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Shock & Vibration Computational Laboratory, Ship shock trial simulations

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Frequently Asked Questions

WHY USE MODELING & SIMULATION?

The use of finite element method ship models allows us to couple a fluid mesh to the ship structural model and accurately predict the dynamic response of the entire ship system to an underwater shock event. By doing this in a "virtual environment", there are many real-life benefits. These include:

- Significant added value to planned full ship shock trials
- A potential to refocus live-fire assets on more realistic threat based testing
- Allows for a greater diversity in explosive shot scenario geometries
- Removes inherent risk to the crew, ship structure, and equipment
- Alleviates operational demands on commissioned ships used in testing
- Eliminates impact on the environment

MODELING & SIMULATION: A REPLACEMENT FOR LFT&E?

While Modeling & Simulation (M&S) can provide excellent results in the prediction of selected ship system dynamic response, it is intended as a design tool to be used in conjunction with various test events – especially Live Fire Testing & Evaluation (LFT&E) events. This process quantifies and improves M&S validity while helping assess the survivability of new ship classes. Moreover, improvements in testing and M&S could help refocus limited survivability assessment resources on tests more representative of realistic threat encounters such as near-field explosions.

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NAVAL POSTGRADUATE SCHOOL

SURFACE SHIP SHOCK TRIAL SIMULATION

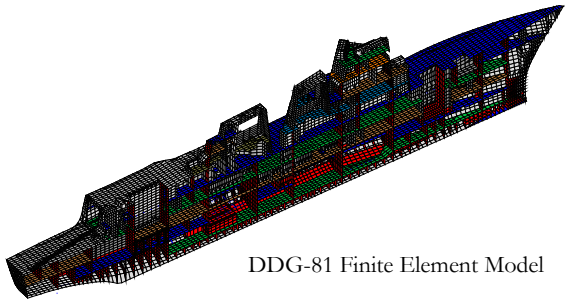
RESEARCH OBJECTIVE

Our goal at the Naval Postgraduate School Shock and Vibration Computational Laboratory (SVCL) has been to develop and validate modeling and simulation capabilities to improve the survivability of ships subjected to realistic underwater explosions.

WHY STUDY UNDEX?

As early as the mid-1800's, the use of underwater explosions (UNDEX) in Undersea Warfare was known to be a genuine threat to surface ships. However it was not until World War II, that naval leaders took notice of a new destructive phenomenon that was responsible for sending scores of ships to the ocean bottom without ever taking a direct hit from a mine or torpedo. Ships sank as a result of explosives detonating beneath their keels, breaking the back of the ship as they were lifted up and then slammed down once again into the water void left by the explosion.

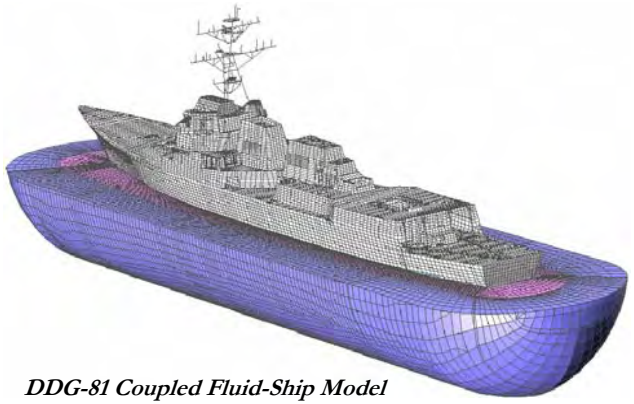
Research into this field started in earnest after the war, spurred by the new guidelines set forth by the Navy aimed at insuring shock hardening of shipboard equipment and systems.



DDG-81 Finite Element Model

The SVCL has participated in many Navy sponsored research programs throughout its over 20 years existence. Some of the more recent ship shock simulation projects that the SVCL Shock Team has been involved in are:

- **DDG-53 USS John Paul Jones**
- **DDG-81 USS Winston S. Churchill**
- **LPD-17 USS San Antonio**
- **DDG-1000 USS Zumwalt**



DDG-81 Coupled Fluid-Ship Model

… Surface ships must be capable of operating in the combat shock environment

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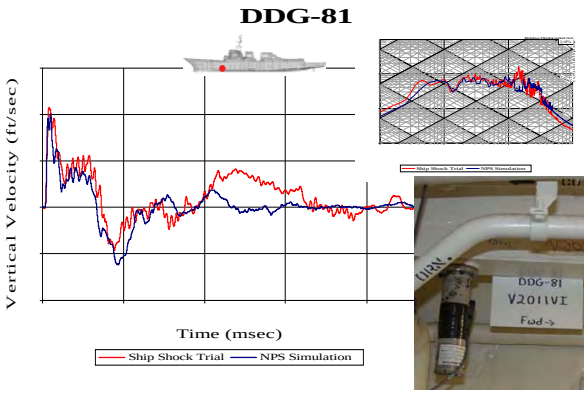
SHOCK SIMULATION PROJECTS

Working with graduate students from the Mechanical and Astronautical Engineering Department, the SVCL research staff have extensively researched and documented the underwater shock phenomena and its damaging effects on ship structures, equipment, and even the human body. Highly complex and powerful as naval combatants are, while operating in an underwater shock environment, their overall mission capability is ultimately constrained by a combination of human and equipment fragility.

Anthropomorphic Test Device and Simulation Model

Investigations have included computer modeling and simulation, biomechanical specimen testing, explosive model testing and vibration panel testing, in both the classified and unclassified formats. Some of the past thesis topics include:

- **Ship Structure Transient Response**
- **Biodynamic Response of Crewmen**
- **Ship System Damping**
- **Effects of Explosive Charge Scaling**
- **Ship Whipping Phenomenon**



Comparison of DDG-81 Simulation and Recorded Data